Official Handbook

of

The Panama Canal

SECOND EDITION—REVISED AND ENLARGED.

COMPILED BY

THE SECRETARY OF THE ISTHMIAN CANAL COMMISSION

Ancon, Canal Zone

1911

Panama Canal

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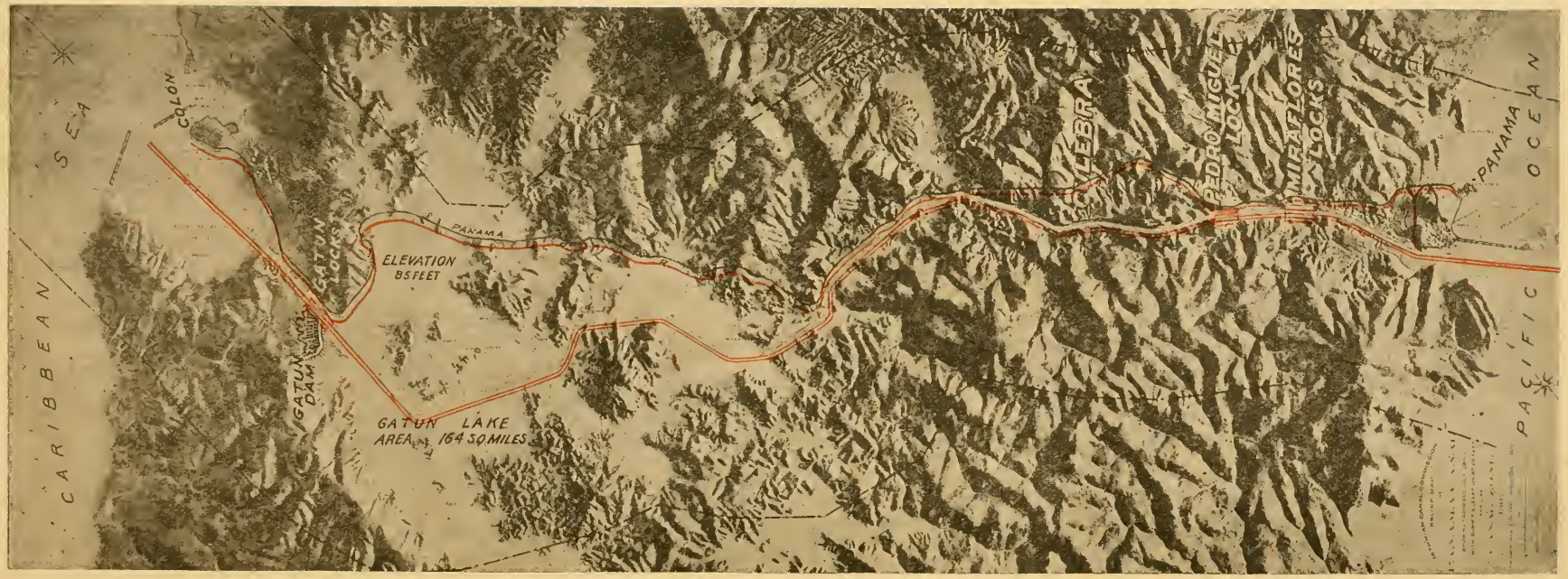
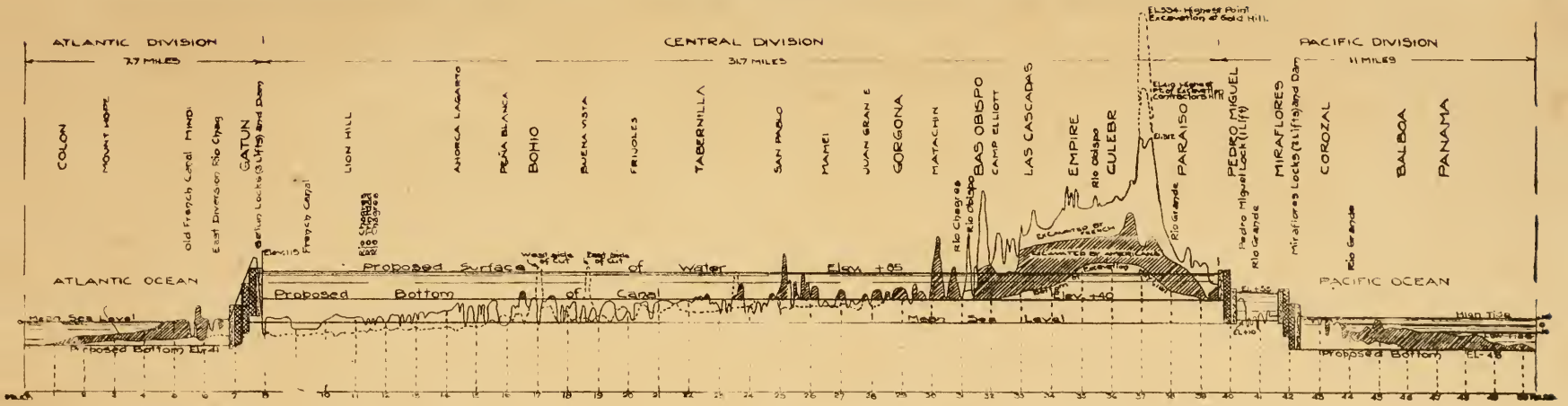
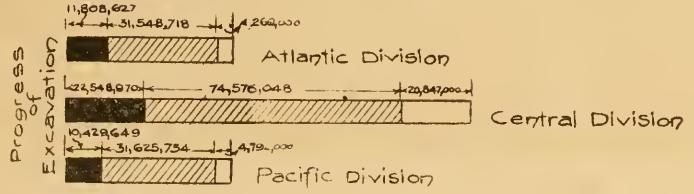
Contents.

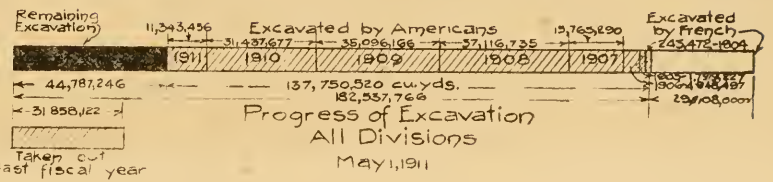


Isthmus with Completed Canal.

Profile of Canal







Canal Statistics.

Length from deep water to deep water (miles)	50
Length from shore-line to shore-line (miles)	40
Bottom width of channel, maximum (feet)	1000
Bottom width of channel, minimum, 9 miles, Culebra Cut (feet)	300
Locks, in pairs	12
Locks, usable length (feet)	1000
Locks, usable width (feet)	110
Gatun Lake, area (square miles)	164
Gatun Lake, channel depth (feet)	85 to 45
Culebra Cut, channel depth (feet)	45
Excavation, estimated total (cubic yards)	182,537,766
Excavation, amount accomplished May 1, 1911 (cubic yards)	137,750,520
Excavation by the French (cubic yards)	78,146,960
Excavation by French, useful to present Canal, (cubic yards)	29,908,000
Excavation by French, estimated value to Canal	$25,389,240
Value of all French property	$42,799,826
Concrete, total estimated for Canal (cubic yards)	5,000,000
Time of transit through completed Canal (hours)	10 to 12
Time of passage through locks (hours)	3
Relocated Panama Railroad, estimated cost	$9,000,000
Relocated Panama Railroad, length (miles)	47.1
Canal Zone, area (square miles)	448
Canal and Panama Railroad force actually at work (about)	35,000
Canal and Panama Railroad force, Americans (about)	5000
Cost of Canal, estimated total	$375,000,000
Work begun by Americans	May 4, 1904
Date of completion	Jan. 1, 1915

The Panama Canal.

THE entire length of the Canal from deep water in the Atlantic to deep water in the Pacific is about 50 miles. Its length from shore-line to shore-line is about 40 miles. In passing through it from the Atlantic to the Pacific, a vessel will enter the approach channel in Limon Bay, which will have a bottom width of 500 feet and extend to Gatun, a distance of about seven miles. At Gatun, it will enter a series of three locks in flight and be lifted 85 feet to the level of Gatun Lake. It may steam at full speed through this lake, in a channel varying from 1,000 to 500 feet in width, for a distance of about 24 miles, to Bas Obispo, where it will enter the Culebra Cut. It will pass through the Cut, a distance of about nine miles, in a channel with a bottom width of 300 feet, to Pedro Miguel. There it will enter a lock and be lowered $30\frac{1}{3}$ feet to a small lake, at an elevation of $54\frac{2}{3}$ feet above sea level, and will pass through this for about $1\frac{1}{2}$ miles to Miraflores. There it will enter two locks in series and be lowered to sea level, passing out into the Pacific through a channel about $8\frac{1}{2}$ miles in length, with a bottom width of 500 feet. The depth of the approach channel on the Atlantic side, where the maximum tidal oscillation is $2\frac{1}{2}$ feet, will be 41 feet at mean tide, and on the Pacific side, where the maximum oscillation is 21 feet, the depth will be 45 feet at mean tide.

Throughout the first 16 miles from Gatun, the width of the Lake channel will be 1,000 feet; then for 4 miles it will be 800 feet, and for 4 miles more, to the northern entrance of Culebra Cut at Bas Obispo, it will be 500 feet. The depth will vary from 85 to 45 feet. The water level in the Cut will be that of the Lake, the depth 45 feet, and the bottom width of the channel 300 feet.

Three hundred feet is the minimum bottom width of the Canal. This width begins about half a mile

The Panama Canal (*Continued.*)

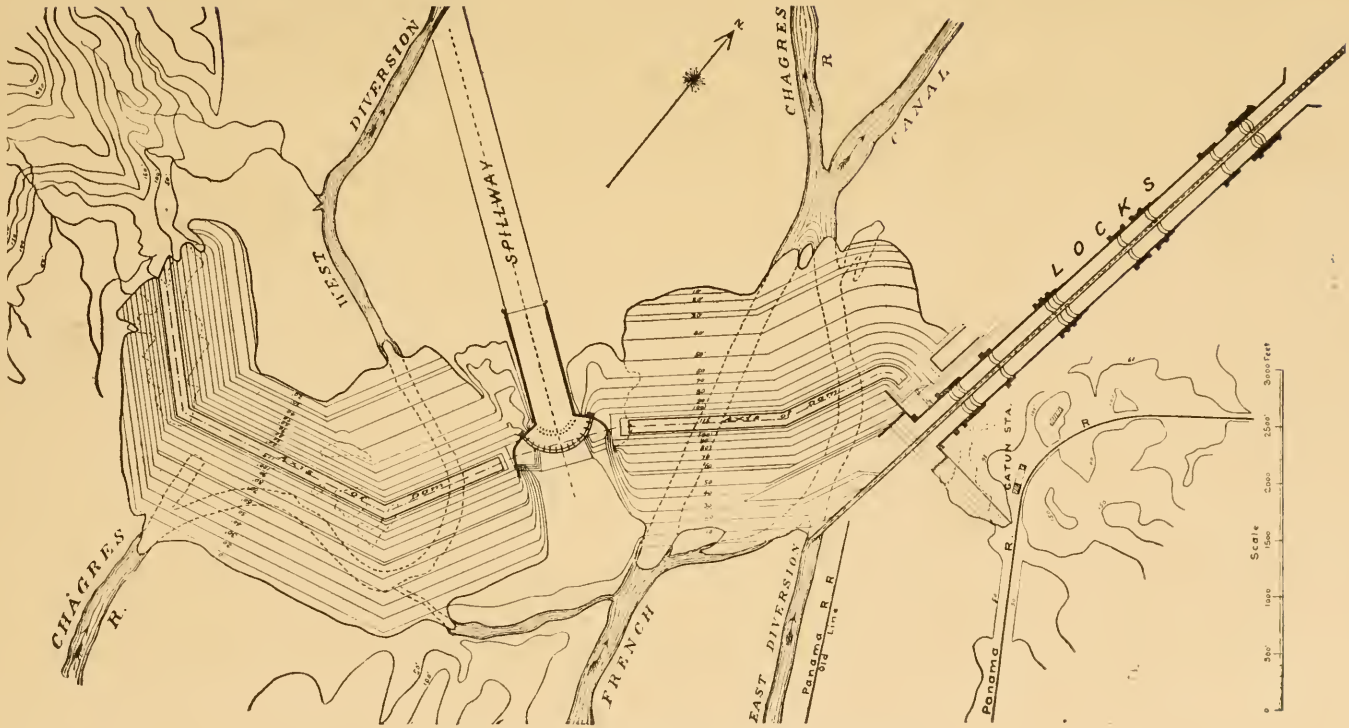
above Pedro Miguel locks and extends about 8 miles through Culebra Cut, with the exception that at all angles the channel is widened sufficiently to allow a thousand-foot vessel to make the turn. The Cut has eight angles, or about one to every mile. The 300-foot widths are only on tangents between the turning basins at the angles. The smallest of these angles is 7° 36′, and the largest 30°.

In the whole Canal there are 22 angles, the total curvature being 600° 51′. Of this curvature, 281° 10′ are measured to the right, going south, and 319° 41′ to the left. The sharpest curve occurs at Tabernilla, and is 67° 10′.

Gatun Dam.

The Gatun Dam, which will form Gatun Lake by impounding the waters of the Chagres and its tributaries, will be nearly $1\frac{1}{2}$ miles long, measured on its crest, nearly $\frac{1}{2}$ mile wide at its base, about 400 feet wide at the water surface, about 100 feet wide at the top, and its crest, as planned, will be at an elevation of 115 feet above mean sea level, or 30 feet above the normal level of the Lake. Of the total length of the Dam only 500 feet, or $\frac{1}{15}$, will be exposed to the maximum water head of 85 feet. The interior of the Dam will be formed of a natural mixture of sand and clay, dredged by hydraulic process from pits above and below the Dam, and placed between two large masses of rock and miscellaneous material obtained from steam shovel excavation at various points along the Canal. The top and upstream slope will be thoroughly riprapped. The entire Dam will contain about 21,000,000 cubic yards of material.

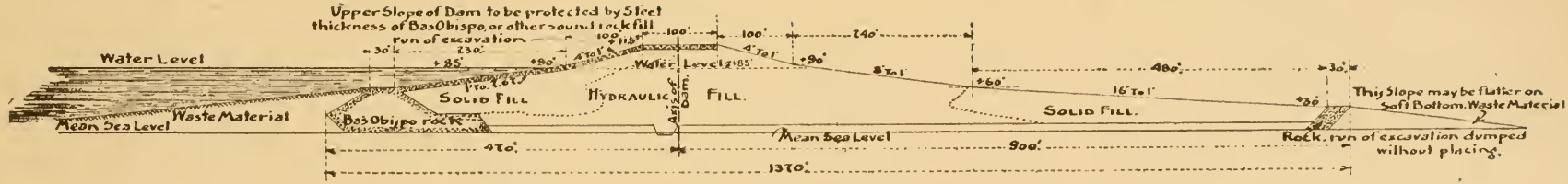
The Spillway is a concrete lined opening, 1,200 feet long and 300 feet wide, cut through a hill of rock nearly in the center of the Dam, the bottom of the opening being 10 feet above sea level. It will contain about 225,000 cubic yards of concrete. During the construction of the Dam, all the water discharged from the Chagres and its tributaries will flow through this opening. When construction has advanced sufficiently to permit the Lake to be formed, the Spillway will be closed with a concrete dam, fitted with gates and machinery for regulating the water level of the Lake.



Gatun Dam, Spillway and Locks.

Water Supply of Gatun Lake.

Gatun Lake will impound the waters of a basin comprising 1,320 square miles. When the surface of the water is at 85 feet above sea level, the Lake will have an area of about 164 square miles, and will contain about 206 billion cubic feet of water. During eight or nine months of the year, the lake will be kept constantly full by the prevailing rains, and consequently a surplus will need to be stored for only three or four months of the dry season. The smallest run-off of water in the basin, during the past 21 years, as measured at Gatun, was about 146 billion cubic feet. In 1910 the run-off was 360 billion cubic feet, or a sufficient quantity to fill the lake one and a half times. The water surface of the Lake will be maintained during the rainy season at 87 feet above sea level, making the minimum channel depth in the Canal 47 feet. As navigation can be carried on with about 41 feet of water, there will be stored for dry season surplus over five feet of water. Making due allowance for evaporation, seepage, leakage at the gates, and power consumption, this would be ample for 41 passages daily through the locks, using them at full length, or about 58 lockages a day when partial length is used, as would be usually the case, and when cross filling from one lock to the other through the central wall is employed. This would be a larger number of lockages than would be possible in a single day. The average number of lockages through the Sault Ste. Marie Canal on the American side was 37 per day in the season of navigation of 1909, which was about eight months long. The average number of ships passed was about $1\frac{1}{2}$ per lockage. The freight carried was more than 30,000,000 tons. The Suez Canal passed about 12 vessels per day, with a total tonnage for the year of 15,500,000.



Cross Section Gatun Dam.

Dams on Pacific Side.

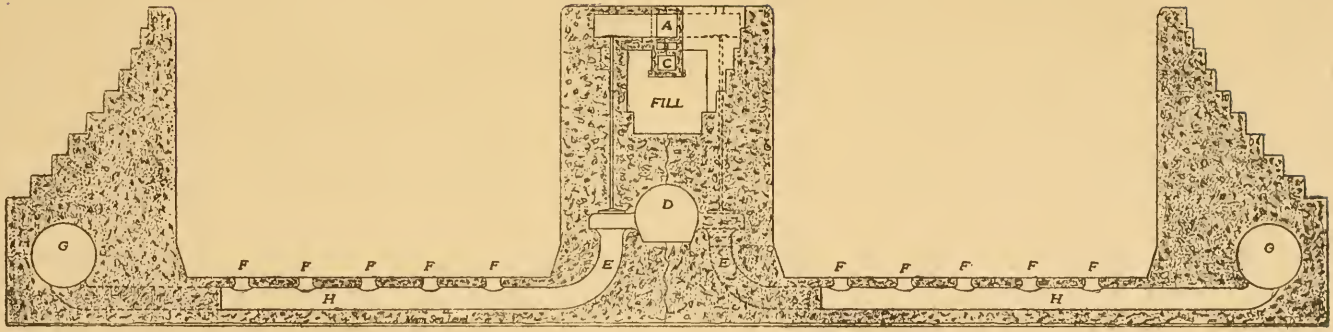
The water level of Gatun Lake, extending through the Culebra Cut, will be maintained at the south end by an earth dam connecting the locks at Pedro Miguel with the high ground to the westward, about 1,400 feet long, with its crest at an elevation of 105 feet above mean tide. A concrete core wall, containing about 700 cubic yards, will connect the locks with the hills to the eastward; this core wall will rest directly on the rock surface and is designed to prevent percolation through the earth, the surface of which is above the Lake level.

A small lake between the locks at Pedro Miguel and Miraflores will be formed by dams connecting the walls of Miraflores locks with the high ground on either side. The dam to the westward will be of earth, about 2,700 feet long, having its crest about 15 feet above the water in Miraflores Lake. The east dam will be of concrete, containing about 75,000 cubic yards; will be about 500 feet long, and will form a spillway for Miraflores Lake, with crest gates similar to those at the Spillway of the Gatun Dam.

The Locks.

There will be 6 double locks in the Canal; three pairs in flight at Gatun, with a combined lift of 85 feet; one pair at Pedro Miguel, with a lift of $30\frac{1}{3}$ feet, and two pairs at Miraflores, with a combined lift of $54\frac{2}{3}$ feet at mean tide. The usable dimensions of all are the same—a length of 1,000 feet, and width of 110 feet. Each lock will be a chamber, with walls and floor of concrete, and mitering gates at each end.

The side walls will be 45 to 50 feet wide at the surface of the floor; will be perpendicular on the face, and will narrow from a point $24\frac{1}{3}$ feet above the floor until they are 8 feet wide at the top. The middle wall will be 60 feet wide, approximately 81 feet high, and each face will be vertical. At a point $42\frac{1}{3}$ feet above the surface of the floor, and 15 feet above the top of the middle culvert, this wall will divide into two parts, leaving a space down the center much like the letter "U," which will be 19 feet wide at the bottom and 44 feet wide at the top. In this center space will be a tunnel divided into three stories, or galleries. The



Cross Section of Lock Chamber and Walls of Locks.

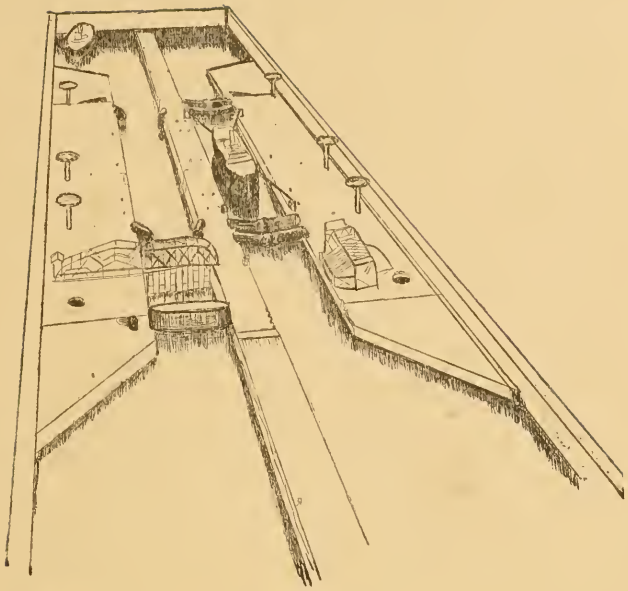
A—Passageway for operators.
B—Gallery for electric wires.
C—Drainage gallery.
D—Culvert in center wall.
E—These culverts run under the lock floor and alternate with those from sidewalls.
F—Wells opening from lateral culverts into lock chamber.
G—Culvert in sidewalls.
H—Lateral culverts.

The Locks (*Continued.*)

lowest gallery will be for drainage; the middle, for the wires that will carry the electric current to operate the gate and valve machinery installed in the center wall, and the upper will be a passageway for the operators.

The lock gates will be steel structures 7 feet thick, 65 feet long, and from 47 to 82 feet high. They will weigh from 300 to 600 tons each. Ninety-two leaves will be required for the entire Canal, the total weighing 57,000 tons. Intermediate gates will be used in the locks, in order to save water and time, if desired, in locking small vessels through, the gates being so placed as to divide the locks into chambers 600 and 400 feet long, respectively. Ninety-five per cent of the vessels navigating the high seas are less than 600 feet long. In the construction of the locks, it is estimated that there will be used approximately 4,200,000 cubic yards of concrete, requiring about the same number of barrels of cement.

Electricity will be used to tow all vessels into and through the locks, and to operate all gates and valves, power being generated by water turbines from the head created by Gatun Lake. Vessels will not be permitted to enter or pass through the locks under their own power, but will be towed through by electric locomotives running on cog-rails laid on the tops of the lock walls. There will be two towing tracks for each flight of locks, one on the side and one on the middle wall. On each side wall there will be one return track and on the middle wall a third common to both of the twin locks. All tracks will run continuously the entire length of the respective flights and will extend some distance on the guide approach walls at each end. The number of locomotives used will vary with the size of the vessel. The usual number required will be four; two ahead, one on each wall, imparting motion to the vessel, and two astern, one on each wall, to aid in keeping the vessel in a central position and to bring it to rest when entirely within the lock chamber. They will be equipped with a slip drum, towing windlass and hawser which will permit the towing line to be



Model of Pedro Miguel Locks.

The lock on the right is nearly filled for an upward lockage. Four electric locomotives are shown securely holding a 10,000-ton ship, and ready to tow it out of the lock, so soon as the upper gates are opened. In the foreground is shown a protective chain; at the entrance to the lock on the left is shown a caisson in position and acting as a barrier between the high level above and the low level below the lock.

On the right is shown an emergency dam in its normal position when not in use and on the left the other dam is shown swung in position across the lock with the wicket girder down in readiness to support the wickets or gates which complete the barrier.

The Locks (*Continued.*)

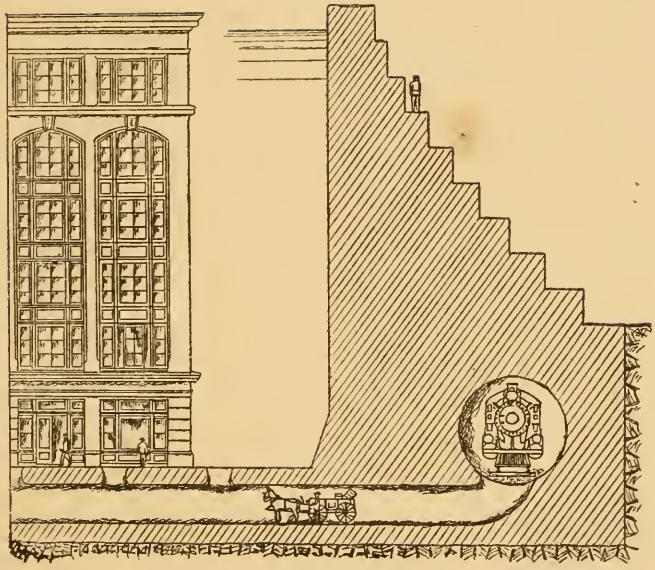
taken in or paid out without actual motion of the locomotive on the track.

The locks will be filled and emptied through a system of culverts. One culvert 254 sq. ft. in area of cross section, about the area of the Hudson River tunnels of the Pennsylvania Railroad, extends the entire length of each of the middle and side walls and from each of these large culverts there are several smaller culverts, 33 to 44 sq. ft. in area, which extend under the floor of the lock and communicate with the lock chamber through holes in the floor. The large culverts are controlled at points near the miter gates by large valves and each of the small culverts extending from the middle wall culvert into the twin chambers is controlled by a cylindrical valve. The large culvert in the middle wall feeds in both directions through laterals, thus permitting the passage of water from one twin lock to another, effecting a saving of water. (*See cuts.*)

To fill a lock the valves at the upper end are opened and the lower valves closed. The water flows from the upper pool through the large culverts into the small lateral culverts and thence through the holes in the floor into the lock chamber. To empty a lock the valves at the upper end are closed and those at the lower end are opened and the water flows into the lower lock or pool in a similar manner. This system distributes the water as evenly as possible over the entire horizontal area of the lock and reduces the disturbance in the chamber when it is being filled or emptied.

The depth of water over the miter sills of the locks will be 40 feet in salt water and $41\frac{1}{3}$ feet in fresh water.

The average time of filling and emptying a lock will be about fifteen minutes, without opening the valves so suddenly as to create disturbing currents in the locks or approaches. The time required to pass a vessel through all the locks is estimated at 3 hours; one hour and a half in the three locks at Gatun, and about the same time in the three locks on the Pacific side. The time of passage of a vessel through the entire Canal is estimated as ranging from 10 to 12 hours, according to the size of the ship, and the rate of speed at which it can travel.



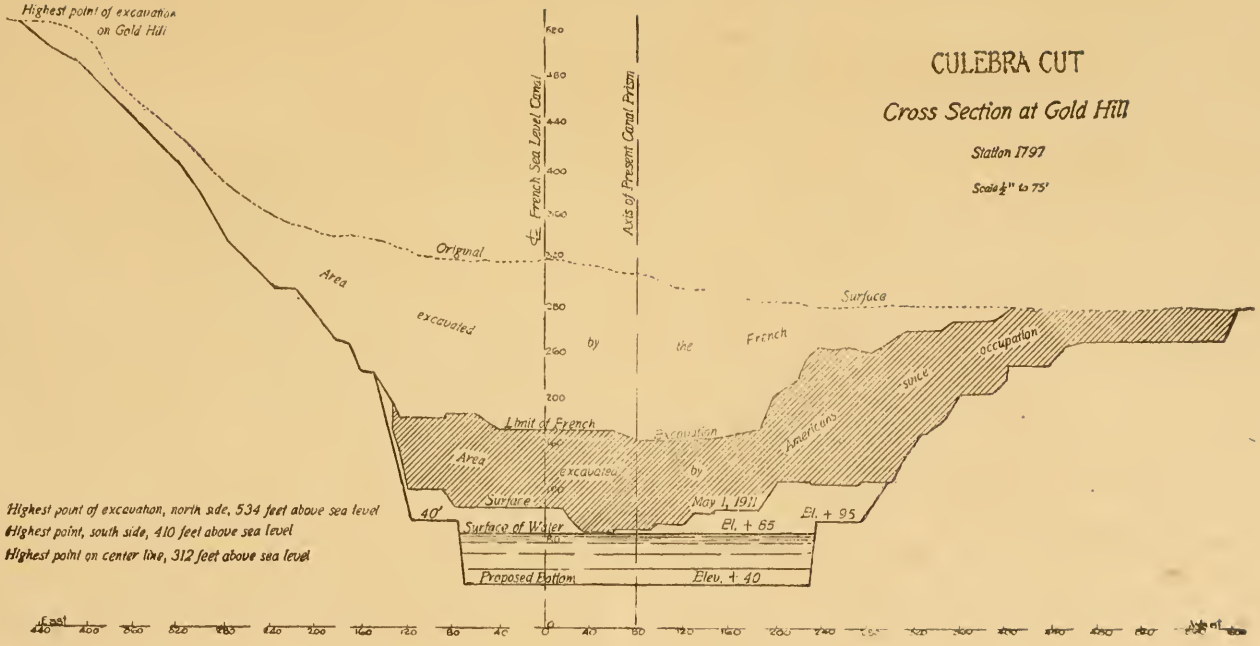
Side Wall of Locks Compared with Six-story Building.

Slides.

There are in all twenty-one slides along the Culebra Cut. Twelve cover areas varying from one to forty-seven acres, and nine cover areas of less than one acre each, making in all a total of one hundred and forty-nine acres. The largest is the Cucaracha slide, on the east side of the Canal, which covers an area of forty-seven acres, and which has broken back 1,820 feet from the center line of the Canal. This slide, according to French records, started as early as 1884, and has given the Americans considerable trouble since they began work. Over two million cubic yards have been removed by the Americans, and the slide is still active. The next largest slide is a combination of two slides on the west side of the Cut at Culebra, just north of Contractor's Hill, covering about twenty-eight acres. Over two million cubic yards have been removed from this slide, and it is estimated that one million cubic yards are still in motion. On the east side of the Cut, north of Gold Hill, is another large slide covering an area of about seventeen acres which has broken back 1,200 feet from the center line of the Canal. Over 416,000 cubic yards have been taken out of this slide and about three-quarters of a million more are still in motion. The total distance across the Cut at this point from back to back of slides is 1,950 feet. In all, over nine million cubic yards have been taken out since July, 1905, because of slides, and over three million cubic yards are still in motion.

Excavation.

The total excavation, dry and wet, for the Canal, as originally planned, was estimated at 103,795,000 cubic yards, in addition to the excavation by the French companies. Changes in the plan of the Canal, made subsequently by order of the President, increased the amount to 174,666,594 cubic yards. Of this amount, 89,794,493 cubic yards were to be taken from the Central Division, which includes the Culebra Cut. In July, 1910, a further increase of 7,871,172 cubic yards was made, of which 7,330,525 cubic yards were to allow for slides in Culebra Cut, for silting in the Chagres section, and for lowering the bottom of the Canal from 40 to 39 feet above sea level in the Chagres section.


CULEBRA CUT
Cross Section at Gold Hill
Station 1797
Scale ½" to 75'
Highest point of excavation on Gold Hill
French Sea Level Canal
Axis of Present Canal Prism
Original Surface
Area excavated by the French
Area excavated by Americans since occupation
Limit of French Excavation
May 1, 1911
El. + 95
El. + 85
Surface of Water
Proposed Bottom
Elev. + 40
40'
Highest point of excavation, north side, 534 feet above sea level
Highest point, south side, 410 feet above sea level
Highest point on center line, 312 feet above sea level
feet

Excavation (*Continued.*)

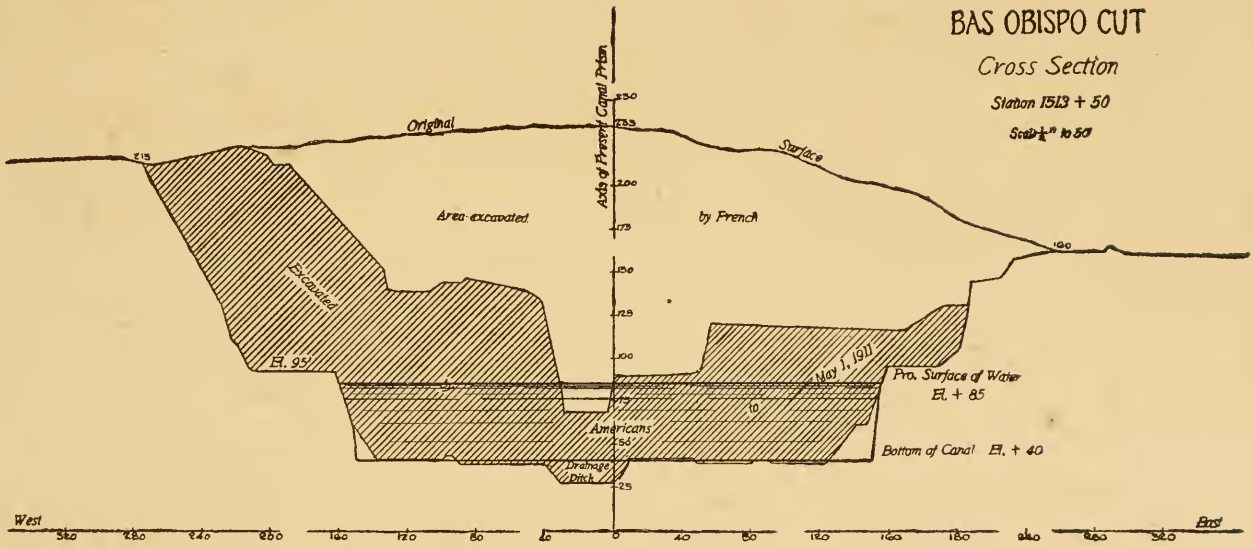
These additions increased the estimated total excavation to 182,537,766 cubic yards. Active excavation work on a large scale did not begin until 1907, when 15,765,290 cubic yards were removed. In 1908, over 37,000,000 cubic yards were removed, and in 1909, over 35,000,000, making a total for the two years of over 72,000,000 cubic yards, or a monthly average for those two years of 3,000,000 cubic yards. In 1910, over 31,000,000 cubic yards were removed, the monthly average exceeding 2,600,000 cubic yards. The total for these three years was nearly three-fifths of the entire excavation for the Canal. Records of all excavation to May 1, 1911, are appended:

By French Companies		78,146,960
French excavation useful to present Canal		29,908,000
By Americans—		
Dry excavation	84,112,947	
Dredges	50,976,485	
		135,089,432
May 4 to December 31, 1904	243,472	
January 1 to December 31, 1905	1,799,227	
January 1 to December 31, 1906	4,948,497	
January 1 to December 31, 1907	15,765,290	
January 1 to December 31, 1908	37,116,735	
January 1 to December 31, 1909	35,096,166	
January 1 to December 31, 1910	31,437,677	
January 1 to May 1, 1911	11,343,456	

EXCAVATION BY DIVISIONS.

May 4, 1904 to May 1, 1911.

Divisions.	Amount excavated.		Remaining to be excavated.	
Atlantic—				
Dry excavation	8,001,503	31,548,718	271,551	11,808,627
Dredges	23,547,215		11,537,076	
Central—				
Culebra Cut	62,814,749	74,576,048	21,371,975	22,548,970
All other points	11,761,299		1,176,995	
Pacific—				
Dry excavation	3,322,902	31,625,754	3,057,240	10,429,649
Dredges	28,302,852		7,372,409	
Grand totals		137,750,520		44,787,246


BAS OBISPO CUT
Cross Section
Station 1513 + 50
Scale 1" to 50'
Axis of Present Canal Prism
Original
Surface
Area excavated
by French
Excavated
El. 95'
May 1, 1911
Pro. Surface of Water
El. + 85
Americans
Bottom of Canal El. + 40
Drainage Ditch
West
East

Capacity of Steam Shovels and Dirt Trains.

There are several classes of steam shovels engaged in excavating work, equipped with dippers ranging in capacity from $1\frac{3}{4}$ cubic yards to 5 cubic yards, and a trenching shovel, which has a dipper with a capacity of $\frac{3}{4}$ of a cubic yard.

Each cubic yard, place measurement, of average rock weighs about 3,900 pounds; of earth, about 3,000 pounds; of "the run of the cut," about 3,600 pounds, and is said to represent about a two-horse cart load. Consequently, a five cubic yard dipper, when full, carries 8.7 tons of rock, 6.7 tons of earth, and 8.03 tons of "the run of the cut."

Three classes of cars are used in hauling spoil—flat cars with one high side, which are unloaded by plows operated by a cable upon a winding drum, and two kinds of dump cars, one large and one small. The capacity of the flat cars is 19 cubic yards; that of the large dump cars, 17 cubic yards, and that of the small dump cars, 10 cubic yards. The flat car train is ordinarily composed of 20 cars in hauling from the cut at Pedro Miguel, and of 21 cars in hauling from the cut at Matachin. The large dump train is composed of 27 cars, and the small dump train of 35 cars.

The average load of a train of flat cars, in hauling the mixed material known as "the run of the cut," is 610.7 tons (based on a 20-car train); of a train of large dump cars, 737.68 tons, and of a train of small dumps, 562.5 tons.

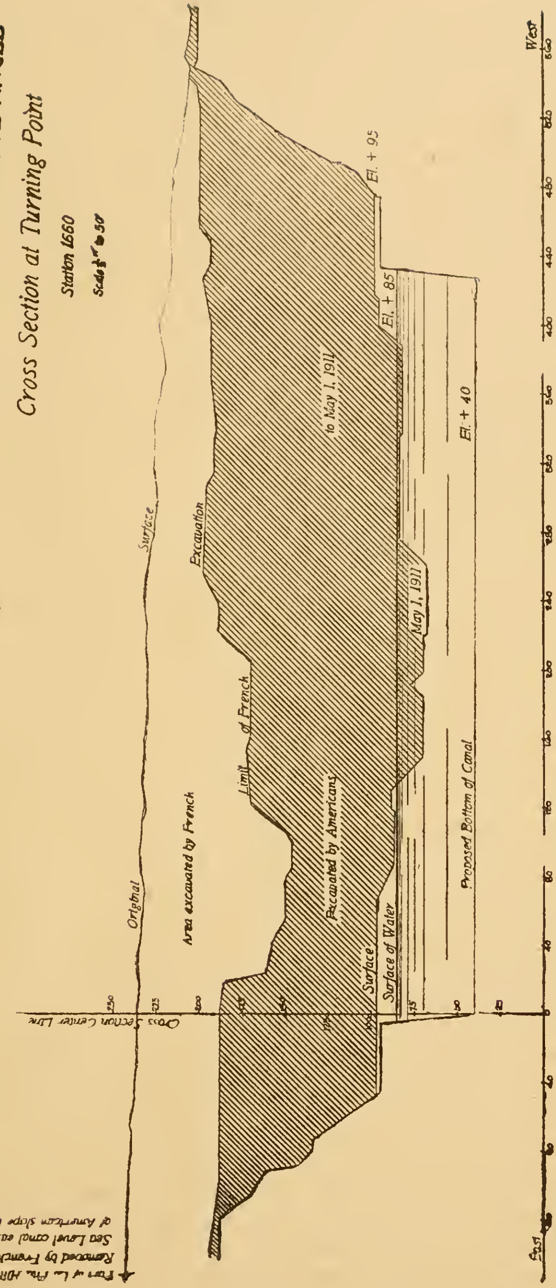
The average time consumed in unloading a train of flat cars is from 7 to 15 minutes; in unloading a train of large dump cars, 15 to 40 minutes; and in unloading a train of small dump cars, 6 to 56 minutes. The large dump cars are operated by compressed air power furnished by the air pump of the locomotive, while the small dump cars are operated by hand.

The record day's work for one steam shovel was that of March 22, 1910, 4,823 cubic yards of rock (place measurement), or 8,395 tons. The highest daily record in the Central Division was on March 11, 1911, when 51 steam shovels and 2 cranes equipped with orange peel buckets excavated an aggregate of 79,484 cubic yards, or 127,742 tons. During this day, 333 loaded trains and as many empty trains were run to and from the dumping grounds.

NORTH OF EMPIRE—CUNETTE ANGLE

Cross Section at Turning Point

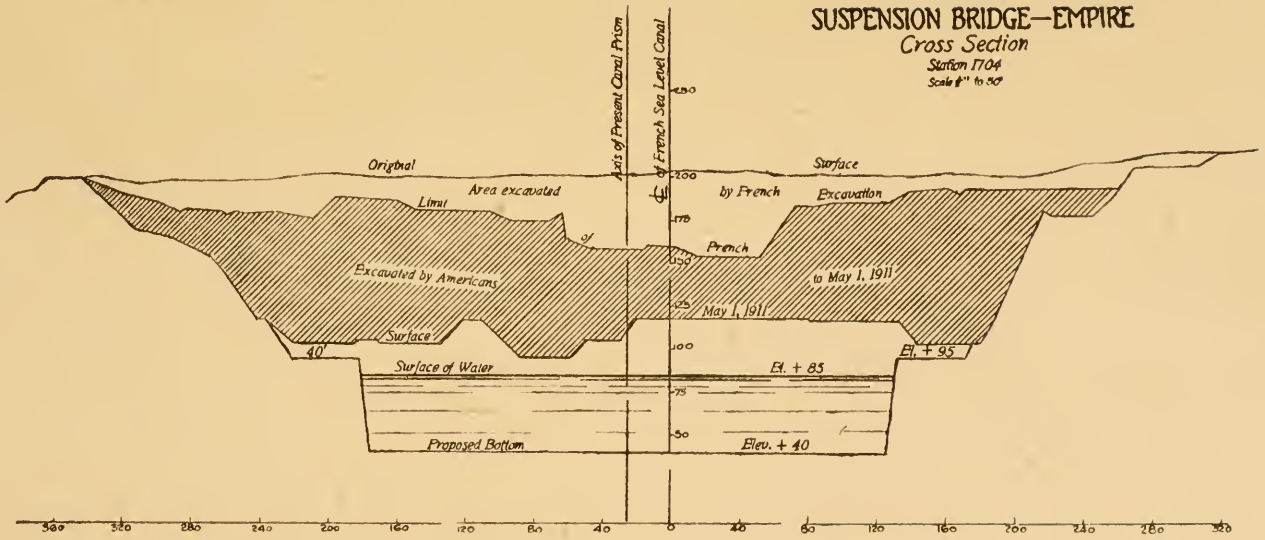
Station 1660



Breakwaters.

Breakwaters are under construction at the Atlantic and Pacific entrances of the Canal. That in Limon Bay, or Colon harbor, extends into the bay from Toro Point at an angle of 42 degrees and 53 minutes northward from a base line drawn from Toro Point to Colon light, and will be 10,500 feet in length, or 11,700 feet, including the shore connection, with a width at the top of fifteen feet and a height above mean sea level of ten feet. The width at the bottom will depend largely on the depth of water. It will contain approximately 2,840,000 cubic yards of rock, the core being formed of rock quarried on the mainland near Toro Point, armored with hard rock from Porto Bello. Work began on the breakwater in August, 1910, and on May 1, 1911, the fill had been extended 4,214 feet. The estimated cost is $5,500,000. A second breakwater has been proposed for Limon Bay, but this part of the project has not been formally acted upon. The purpose of the breakwaters is to convert Limon Bay into a safe anchorage, to protect shipping in the harbor of Colon, and vessels making the north entrance to the Canal, from the violent northers that are likely to prevail from October to January, and to reduce to a minimum the amount of silt that may be washed into the dredged channel.

The breakwater at the Pacific entrance will extend from Balboa to Naos Island, a distance of about 17,000 feet, or a little more than three miles. It will lie from 900 to 2,700 feet east of and for the greater part of the distance nearly parallel to the axis of the Canal prism; will vary from 20 to 40 feet in height above mean sea level, and will be from 50 to 3,000 feet wide at the top. It is estimated that it will contain about 18,000,000 cubic yards of earth and rock, all of which will be brought from Culebra Cut. It is constructed for a two-fold purpose; first, to divert cross currents that would carry soft material from the shallow harbor of Panama into the Canal channel; second, to insure a more quiet harbor at Balboa. Work was begun on it in May, 1908. On May 1, 1911, it had been constructed for a distance of 13,000 feet.


SUSPENSION BRIDGE—EMPIRE
Cross Section
Station 1704
Scale 1" to 50'
Axis of Present Canal Prism
℄ of French Sea Level Canal
Original Surface
Area excavated by French Excavation
Limit of French
Excavated by Americans to May 1, 1911
May 1, 1911
Surface
40'
Surface of Water
El. + 85
El. + 95
Proposed Bottom
Elev. + 40
250
200
175
150
125
100
75
50
360
320
280
240
200
160
120
80
40
0
40
80
120
160
200
240
280
320

Canal Force, Quarters and Supplies.

The Canal force is recruited and housed by the Quartermaster's Department which has two general branches, labor and quarters, and material and supplies. Through the labor and quarters branch there have been brought to the Isthmus 43,432 laborers, of whom 11,797 came from Europe, 19,448 from Barbados, the balance from other islands in the West Indies and from Colombia. No recruiting is required at present, the supply of labor on the Isthmus being ample.

On May 1, 1911, the total force of the Isthmian Canal Commission and Panama Railroad Company, actually at work, was divided as follows:

	Gold	Silver	Total
Isthmian Canal Commission	4,540	23,592	28,132
Panama Railroad Company (proper)	467	3,639	4,106
Panama Railroad Relocation	121	2,201	2,322
Panama Railroad Commissary	219	800	1,019
Totals	5,347	30,232	35,579

The gold force is made up of the officials, clerical force, construction men, and skilled artisans of the Isthmian Canal Commission and the Panama Railroad Company. Practically all of them are Americans. The silver force represents the unskilled laborers of the Commission and the Panama Railroad Company. Of these, about 4,500 are Europeans, mainly Spaniards, with a few Italians and other races. The remainder, about 25,000, are West Indians, about 3,700 of whom are employed as artisans receiving 16, 20, and 25 cents, and a small number, 32 and 44 cents, an hour. The standard rate of the West Indian laborer is 10 cents an hour, but a few of these doing work of an exceptional character are paid 16 and 20 cents. The larger part of the Spaniards are paid 20 cents an hour, and the rest 16 cents an hour.

The material and supply branch carries in eight general storehouses a stock of supplies for the Commission and Panama Railroad valued approximately at $4,500,000. About $12,000,000 worth of supplies are purchased annually, requiring the discharge of one steamer each day.

Food, Clothing and Other Necessaries.

The Canal and Panama Railroad forces are supplied with food, clothing and other necessaries through the Subsistence Department, which is divided into two branches—Commissary and Hotel. It does a business of about seven million five hundred thousand dollars per annum. The business done by the Commissary Department amounts to about $6,000,000 per annum, and that done by the hotel branch to about $1,500,000 per annum.

The Commissary system consists of 22 general stores in as many Canal Zone villages and camps along the relocated line of the Panama Railroad. It is estimated that with employes and their dependents, there are about 65,000 people supplied daily with food, clothing, and other necessaries. In addition to the retail stores, the following plants are operated at Cristobal: cold storage, ice making, bakery, coffee roasting, ice cream, laundry and packing department.

A supply train of 21 cars leaves Cristobal every morning at 4 a. m. It is composed of refrigerator cars containing ice, meats and other perishable articles, and ten containing other supplies. These are delivered at the stations along the line and distributed to the houses of employes by the Quartermaster's Department.

The hotel branch maintains the Hotel Tivoli at Ancon, and also 18 hotels along the line for white gold employes at which meals are served for thirty cents each. At these 18 hotels there are served monthly about 200,000 meals. There are sixteen messes for European laborers, who pay 40 cents per ration of three meals. There are served at these messes about 270,000 meals per month. There are also operated for the West Indian laborers fourteen kitchens, at which they are served a ration of three meals for 27 cents per ration. There are about 100,000 meals served monthly at these kitchens. The supplies for one month for the line hotels, messes and kitchens cost about $85,000; labor and other expenses about $17,500. The monthly receipts, exclusive of the revenue from the Hotel Tivoli, amount to about $105,000.

Value of the $40,000,000 French Purchase.

A careful official estimate has been made by the Canal Commission of the value to the Commission at the present time of the franchises, equipment, material, work done, and property of various kinds for which the United States paid the French Canal Company $40,000,000. It places the total value at $42,799,826, divided as follows:

Excavation, useful to the Canal, 29,708,000 cubic yards	$25,389,240.00
Panama Railroad Stock	9,644,320.00
Plant and material, used and sold for scrap	2,112,063.00
Buildings, used	2,054,203.00
Surveys, plans, maps and records	2,000,000.00
Land	1,000,000.00
Clearings, roads, etc	100,000.00
Ship channel in Panama Bay, four years' use	500,000.00
Total	$42,799,826.00

The Canal Zone.

The Canal Zone contains about 448 square miles. It begins at a point three marine miles from mean low water mark in each ocean, and extends for five miles on each side of the center line of the route of the Canal. It includes the group of islands in the Bay of Panama named Perico, Naos, Culebra, and Flamenco. The cities of Panama and Colon are excluded from the Zone, but the United States has the right to enforce sanitary ordinances in those cities, and to maintain public order in them in case the Republic of Panama should not be able, in the judgment of the United States, to do so.

Of the 448 square miles of Zone territory, the United States owns the larger portion, the exact amount of which is being determined by survey. Under the treaty with Panama, the United States has the right to acquire by purchase, or by the exercise of the right of eminent domain, any lands, buildings, water rights, or other properties necessary and convenient for the construction, maintenance, operation, sanitation, and protection of the Canal, and it can, therefore, at any time acquire the lands within the Zone boundaries which are owned by private persons.

Canal Appropriations and Expenditures.

APPROPRIATIONS

Payment to the New Panama Canal Company	$40,000,000.00
Payment to Republic of Panama	10,000,000.00
Appropriation, June 28, 1902	10,000,000.00
Appropriation, December 21, 1905	11,000,000.00
Deficiency, February 27, 1906	5,990,786.00
Appropriation, June 30, 1906	25,456,415.08
Appropriation, March 4, 1907	27,161,367.50
Deficiency, February 15, 1908	12,178,900.00
Appropriation, May 27, 1908	29,187,000.00
Deficiency, March 4, 1909	5,458,000.00
Appropriation, March 4, 1909	33,638,000.00
Deficiency, February 25, 1910	76,000.00
Appropriation, June 25, 1910	37,855,000.00
Private Act. Relief of Elizabeth G. Martin	1,200.00
Private Act. Relief of Marcellus Troxell	1,500.00
Private Act. Relief of W. L. Miles	1,704.18
Private Act. Relief of Chas. A. Caswell	1,056.00
Appropriation, March 4, 1911	45,560,000.00
Total	$293,566,928.76

CLASSIFIED EXPENDITURES TO APRIL 1, 1911

Department of Construction and Engineering	$108,841,789.99
Department of Construction of Engin'ring—Plant	8,581,385.30
Department of Sanitation	12,775,053.94
Department of Civil Administration	4,714,030.52
Panama Railroad, Second Main Track	1,125,766.28
Panama Railroad, Relocated Line	6,331,631.48
Purchase and Repair of Steamers	2,657,384.88
Zone Water Works and Sewers	4,365,053.09
Zone Roadways	1,512,869.34
Loans to Panama Railroad	3,247,332.11
Construction and Repair of Buildings	9,949,267.23
Purchase from New Panama Canal Company	40,000,000.00
Payment to Republic of Panama	10,000,000.00
Miscellaneous	4,127,106.76
Total	$218,228,670.92

The balances carried in expenditure accounts, which are included in the last item above, for water works, sewers and pavements in the cities of Panama and Colon amounted altogether to $2,146,695.52. The unexpended balance in the appropriation for sanitation in the cities of Panama and Colon, available for expenditures on water works, sewers and pavements was $334,965.56, including transfer of appropriations for quarter ended March 31.

Relocated Panama Railroad.

The new, or relocated line of the Panama Railroad is 47.1 miles long, or slightly shorter than the old line. From Colon to Mindi, 4.17 miles, and from Corozal to Panama, 2.83 miles, the old location is used, but the remaining 40 miles are new road. From Mindi to Gatun the railroad runs, in general, parallel to the Canal, and ascends from a few feet above tide water elevation to nearly 95 feet above. At Gatun the road leaves the vicinity of the Canal and runs east along the valley of the Gatun River to a point about $4\frac{1}{2}$ miles from the center line of the Canal, where it turns southward again and skirts the east shore of Gatun Lake to the beginning of Culebra Cut, at Bas Obispo. In this section there are several large fills, occurring where the line crosses the Gatun Valley and near the north end of Culebra Cut, where the line was located so as to furnish waste dumps for the dirt from the Canal. Originally it was intended to carry the railroad through Culebra Cut on a 40-foot berm, 10 feet above the water level, but the numerous slides have made this plan impracticable and a line is now being constructed around the Cut, known locally as the Gold Hill Line. Leaving the berm of the Canal at Bas Obispo, the Gold Hill Line gradually works into the foot hills, reaching a distance from the center line of the Canal of two miles opposite Culebra; thence it runs down the Pedro Miguel Valley to Paraiso, where it is only 800 feet from the center line of the Canal. This section of the line is located on maximum grade of 1.25 per cent. compensated, and has a total length of $9\frac{3}{8}$ miles. The sharpest curve on the whole line is 7°. From the south end of Culebra Cut at Paraiso, the railroad runs practically parallel with the Canal to Panama, with maximum grade of 0.45 per cent. Where the railroad crosses the Gatun River, a bascule steel bridge is to be erected. and a steel girder bridge, $\frac{1}{4}$ mile long, with 200-foot through truss channel span, is in use across the Chagres River at Gamboa. Small streams are crossed on reinforced concrete culverts. Near Miraflores, a tunnel 736 feet long has been built through a hill. Total cost of new line is estimated at $9,000,000.

Equipment.

CANAL SERVICE.

Steam shovels:		
105-ton, 5 cubic yard dippers	14	
95-ton, 4 and 5 cubic yard dippers	32	
70-ton, $2\frac{1}{2}$ and 3 cubic yard dippers	35	
66-ton, $2\frac{1}{2}$ cubic yard dippers	7	
45-ton, $1\frac{3}{4}$ cubic yard dippers	10	
26-ton	1	
Trenching shovel, $\frac{3}{4}$ cubic yard dipper,	1	
Total		100
Locomotives:		
American:		
106 tons	99	
105 tons	39	
117 tons	20	
		158
French:		
20 tons	5	
26 tons	46	
27 tons	9	
30 tons	42	
Decauville	10	
		112
Narrow gage, American, 16 tons	33	
Electric	12	45
Total		315
Drills:		
Mechanical churn, or well	265	
Tripod	295	
Total		560
Cars:		
Flat, used with unloading plows	1802	
Steel dumps, large	600	
Steel dumps, small	1200	
Ballast dumps	25	
Wooden dumps	12	
Steel flats	500	
Narrow gage	200	
Motor	6	
Pay Car	1	
Total		4,346

Spreaders		25
Track shifters		10
Unloaders		30
Pile drivers		19
Dredges:		
French ladder	7	
Dipper	3	
Pipe-line	7	
Sea going suction	2	
Clam shell	1	
Total		20
Cranes		57
Rock breaker		1
Tugs		12
Tow boat		1
House boats		2
Clapets		11
Pile driver, floating		1
Crane boat		1
Barges, lighters and scows		70
Launches		14
Cutters		3
Drill boats		2

PANAMA RAILROAD

Locomotives:		
Road, (12 oil burners)	36	
Switch	34	
Total		70
Cars:		
Coaches	57	
Freight	1477	
Total		1,534
Locomotive crane		1
Pile driver, track		1
Pile driver, floating		1
Tugs		2
Lighters:		
Coal, all steel	5	
Cargo, steel and iron	8	
Total		13

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